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旌节花科及其相关类群花粉形态的研究*

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摘要：对旌节花科及其相关类群五桠果科、猕猴桃科、水东哥科、金莲木科、省沽油科和山茶科等7科19属37种花粉进行了光镜（LM）和扫描电镜（SEM）的观察和比较。其中有些种类是第一次观察和报道。研究表明，上述各科花粉多为近球形至球形，少数近扁球形或近长球形。极面观三裂圆形或近三裂圆形。直径20～30（～35）μm，但厚皮香亚科和省沽油科银鹊树属 *Tapiscia* 的花粉特别小，仅12.5～20 μm。3孔沟，罕有3沟或4孔沟。外萌发孔（沟）相对地较长而宽，内孔多数较发达。花粉外壁纹饰变化大，从模糊而粗糙的细突起到皱波状纹饰，细孔状纹饰，蜂巢状～穴状纹饰，穴～网状纹饰，网状纹饰和颗粒状纹饰等。从形状、大小、萌发孔类型和外壁纹饰的比较看，虽然上述各科花粉均在不同程度上具有一定的相似性，但其中以旌节花科、省沽油科和山茶科中厚皮香亚科的花粉具有更多的相似性，尤其表现在外壁纹饰特征上。就孢粉学而言，也许旌节花科与省沽油科和山茶科中的厚皮香亚科的关系相对地较为密切。不过，其孢粉学特征所表现出的亲缘关系似乎不如在分子生物学中所表现出的明显。

关键词：旌节花科；五桠果科；猕猴桃科；水东哥科；山茶科；省沽油科；金莲木科；花粉形态
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Pollen Morphology of Stachyuraceae and Related Taxa*

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Abstract：The pollen grains of 37 species belonging to 19 genera of 7 families，i.e.，Stachyuraceae，Dilleniaceae，Actinidiaceae，Saurauiaceae，Ochnaceae，Staphyleaceae and Theaceae were examined by light and scanning electron microscopes. Some species were examined by scanning electron microscope or reported for the first time. The result showed that most pollen grains are 3-lobed circular or sub-3-lobed circular in outline in polar view，the shape varies from suboblate to subprolate but most are subspheroidal to spheroidal. The pollen size ranges from 12.5－20 μm in Ternstroemoideae（Theaceae）and *Tapiscia*

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(Staphyleaceae) to 20 – 30 (35) μm in other taxa in diameter. Most pollen grains are 3-colporate, rarely 3-colpate or 4-colporate. Ectoapertures (colpi) are long and wide relatively; endoapertures (ora) are medium developed to well developed commonly. The exine surface can be divided into faintly scabrous, rugulate, punctate, foveolate, reticulate and granulate sculpture types etc., and the sculpture types are valuable in the delimitation of the families. The comparison of pollen shape, size, aperture type and exine sculpture showed that Stachyuraceae, Staphyleaceae and Ternstroemoideae (Theaceae) are more similar, especially in exine sculpture, for example, the sculpture of Stachyuraceae and Ternstroemoideae (Theaceae) is punctate to foveolate but that of Staphyleaceae is foveolate to finely reticulte. However, their relationships showed in palynology are not so obvious as showedin molecular biology as reported by Nandi *et al*.
Key words: Stachyuraceae; Dilleniaceae; Actinidiaceae; Saurauiaceae; Staphyleaceae; Theaceae; Ochnaceae; Pollen morphology.

Stachyuraceae is a family of Lower Dillenidae (or Subclass Dilleniidae) which was restricted to some primitive and less differentiation taxa in Dillenidae. As a small family of only one genus *Stachyurus*, Stachyuraceae has usually been placed next to different families such as Theaceae, Dilleniaceae, Actinidiaceae, Saurauiaceae, Ochnaceae or other families of Theales, or even next to Flacourtiaceae or Violaceae in Violales (How Foon-Chew, 1982; Brummitt, 1992; Cronquist, 1981; Takhtajan, 1980, 1997; Willis, 1973). Its relationships to other families in Lower Dillenidae have been controversial. In the systems of Thorne, Young and Takhtajan, Stachyuraceae was placed next to Dilleniaceae and Actinidiaceae but ahead of Theaceae; in Dahlgren 's system, Stachyuraceae was placed next to Ochnaceae and Dilleniaceae but far away from Actinidiaceae (Brummitt, 1992; Takhtajan, 1997). Recently, the cladistic analysis using molecular and non-molecular data showed that Stachyuraceae has a close affinity to Staphyleaceae of Subclass Rosidae and is a sister to Crossosomataceae distributed in N. America (Nandi *et al*, 1998).

This paper made a study, using LM and SEM, of pollen morphology of Stachyuraceae and other related families with an emphasis on exine sculpture in order to assess phylogenetic relationships of Stachyuraceae and other families. Though palynology studies of above families were reported (Tong *et al*., 1983; Zhang, 1987; Wei *et al*., 1992, 1996; Wei, 1997; Wei *et al*. 1998, 1999; Dickison *et al*., 1982; Dickison, 1987; Jin and Wei, 2002), an overall comparison of palynology among these families is scanty so far. Here the authors made a detailed comparison of pollen morphological characters of the above families.

1 Materials and methods

Pollen grains were removed from herbarium sheets deposited at the Herbarium of Kunming Institute of Botany, CAS (KUN) and the Herbarium of Chengdu Institute of Biology, CAS (CDBI), or collected directly from living materials planted in Wuhan Institute of Botany, CAS. Some pollen grains were collected from Yimen Xian, Yunnan Province by authors.

Pollen grains for light microscope observation were prepared by Erdtman 's acetolysis method. Acetolysed pollen grains were mounted in glycerin jelly and their sizes were calculated from 15 to 20

grains per sample. For SEM, the pollen grains were vacuum coated with gold and observed directly with SEM Hitachi S 800 at 30kV.

2 Results

2.1 Description of Pollen Morphology

Stachyuraceae, only one genus *Stachyurus* Sieb. & Zucc., 10 – 12 (14) species distributed in E. Asia.

Pollen shape subspheroidal to subprolate and 3-lobed circular in outline in polar view; ca. 18 – 28.2 μm P × 17.5 – 26.5 μm E; 3-colporate and the colpus membrane was covered with granules more or less; the exine surface punctate to foveolate. There is no obvious difference in shape, size and even the density and distribution of foveolae among species in the genus with the exception of *S. salicifolius* in which the foveolae are not very obvious and the distribution of foveolae is uneven (Plate I: 9 – 10). In *S. retusus* (Plate I: 1), *S. sinensis* (Plate I: 2 – 3), *S. yunnanensis* (Plate I: 4 – 5), *S. cordatulus* (Plate I: 6), *S. praecox* (Plate I: 7 – 8), *S. oblongifolius* (Plate I: 11), *S. himalaicus* (Plate I: 12) and *S. obovatus* (Plate II: 1 – 2), the foveolae (exine perforations) are very similar. The length and wide of colpus are different among species and with longer colpi in *S. retusus* (Plate I: 1) and *S. salicifolius* (Plate I: 9 – 10), and shorter or medium-length colpi in *S. sinensis* (Plate I: 2 – 3), *S. oblongifolius* (Plate I: 11), *S. yunnanensis* (Plate I: 4 – 5) and *S. obovatus* (Plate II: 1 – 2). As a whole, the pollen morphology of the family is nearly consistent among species except *S. salicifoius* which shows some difference from others. The detailed pollen morphological data were listed in table 1.

Table 1　Comparison of pollen morphology of Stachyuraceae and related taxa

taxa	Voucher specimens location & No.	pollen shape	aperture types	sculpture	plates
S. retusus Yang	Zhenxiong, Yunnan NE Yunnan Team 1067	spheroidal – subspheroidal	3-colporate	punctate to foveolate	I: 1
S. chinensis Franch.	Guizhou Deng Chaoyi 0525	spheroidal – subspheroidal	3-colporate	punctate to foveolate	I: 2 – 3
S. yunnanensis Franch.	Xichou, Yunnan Wei Zhongxin 2001 – 5	subprolate	3-colporate	punctate to foveolate	I: 4 – 5
S. cordatulus Merr.	Gongshan, Yunnan Dulong Team 1606	subprolate	3-colporate	punctate to foveolate	I: 6
S. praecox Sieb. et Zucc.	Japan Takahoshi, M. 150	spheroidal – subspheroidal	3-colporate	punctate to foveolate	I: 7 – 8
S. salicifolius Franch.	Emei Mt., Sichuan Yang Guanghui 54217	spheroidal – subspheroidal	3-colporate	foveolate with Rugae	I: 9 – 10
S. oblongifolius Wang et Tang	Nanchong, Sichuan Liu Zhengyu 15247	spheroidal – subspheroidal	3-colporate	punctate to foveolate	I: 11
S. himalaicus Hook.f.& Thoms	Yimen, Yunnan Wei Zhongxin 2000 – 21	spheroidal – subspheroidal	3-colporate	Punctate to foveolate	I: 12
S. obovatus (Rehd.) Li	Emei Mt., Sichuan S. L. Sun 1423	spheroidal – subspheroidal	3-colporate	punctate to foveolate	II: 1 – 2
Davilla kunthii	Mexico, Aguazul D.E. Breedlove 57243	spheroidal	3-colporate	reticulate	II: 3 – 4

续表 1

taxa	Voucher specimens location & No.	pollen shape	aperture types	sculpture	plates
Tetracera asiatica (Lour.)Hoogl.	Yining, Guangxi Zhong Shuquan 61945	spheroidal	3-colporate	reticulate	II: 5 – 6
Hibbertica riparia	Austria, Track R. V. Smith 59121	spheroidal	3-colporate	reticulate	II: 7 – 8
Ochna integerrima (Lour) Merr.	Yaxian, Hainan Hou Kuanzhao 7114	spheroidal	3-colporate	faintly granulate	II: 9 – 10
Actinidia chinensis Planch.	Wuhan Bot. Gard.	prolate	3-colporate	faintly granulate	II: 11
A. lijiangensis Liang	Wuhan Bot. Gard.	prolate	3-colporate	faintly granulate	II: 12
A. guilinensis Liang	Wuhan Bot. Gard.	subprolate	3-colporate	faintly granulate	III: 1
A. macrosperm Liang	Kunning Bot. Gard.	subspheroidal	3-colporate	faintly granulate	III: 2 – 3
Clematoclethra lasioclada Maxim.	Emei Mt., Sichuan Sich. med. team 12825	subspheroidal	3-colporate	faintly granulate	III: 4
C. actinidioides Maxim.	Heishui, Sichuan SiCh. Ec. pl. T. 1331	subspheroidal – subprolate	3-colporate	faintly granulate	III: 5
Saurauia thyrsiflora Liang	Xingyi, Guizhou WeiZhongxin 1999 – 10	subspheroidal	3, 4-colporate	punctate to foveolate	III: 6
Anneslea fragrans Wall.	Yunnan Zhu Taiping 0418	spheroidal	3-colporate	near psilate to foveolate	III: 7 – 8
Cleyera albopunctata	Puerto Rico Howard 16820	spheroidal	3-colporate	foveolate	III: 9
Apterosperma oblata Chang	Guangdong Ye Chuanxin (?)	suboblate	3-colporate	near psilate to foveolate	III: 10
Adinandra millettii (H.& A.)Benth. & Hook. f.	Guangxi Guangxi Team 2843	spheroidal	3-colporate	near psilate to foveolate	III: 11 – 12
Staphylea forrestii Balf. f.	Songming, Yunnan Qiu Bingyun 54711	subspheroidal	3-colporate	foveolate to reticulate	IV: 1 – 2
S. bumalda DC.	Japan Im. & Kawahara 9708	subspheroidal	3-colporate	foveolate to reticulate	IV: 3 – 4
Turpinia pomifera (Roxb.) DC.	Zhenkang, Yunnan Wang 72765	subspheroidal	3-colporate	foveolate to reticulate	IV: 5 – 6
T. affinis Merr. & perry	Gengma, Yunnan Wang 72765	subspheroidal	3-colporate	foveolate to reticulate	IV: 7 – 8
Tapiscia sinensis Oliv.	Damiaoshan, Guangx ChenShaoqing 14553	subspheroidal	3-colpate	finely reticulate	IV: 9 – 10
T. yunnanensis W.C. Cheng et C.D.Chu	Malipo, Yunnan Feng Guonei 22826	subspheroidal	3-colpate	finely reticulate	IV: 11 – 12
Camellia luopingensis	Luoping, Yunnan Sun Hang 479	suboblate	3-colporate	rugulate granulate	V: 1
C. oleifera Abel	Yunnan Sun Hang 0138	suboblate	3-colporate	rugulate	V: 2
C. indochinensis Merr.	Guizhou S. Guizhou Team 287	suboblate	3-colporate	rugulate	V: 3
C. sinensis (L.) D. Kuntze	Yunnan Li Yanhui 125	suboblate	3-colporate	rugulate	V: 4
Schima bambusifolia Hu	Yunnan Ye Chuanxin (?)	subprolate	3-colporate	reticulate	V: 5
Tutcheria pubicostata Chang	Yunnan Eshan Team 6261	subprolate	3-colporate	rugulate	V: 6

2.2 Dilleniaceae

Davilla Vand.，only study one species，i.e. *D. kunthii*（Plate II：3－4）.

Pollen shape subspheroidal and 3-lobed circular in polar view；（20.4－25.5）23.8 μm P×21.7（17.9－24.2）μm E；3-colporate，the colpus membrane was covered with small granules；the exine surface finely reticulate，and the size of lumina is different in the whole pollen surface，for example in polar regions and mesocolpia the lumina are bigger（Plate II：4）but along the colpus margins there is an obvious reduction in lumina size.（Plate II：3，arrow）. The surface between lumina is relatively smooth.

Tetracera L. only study *T. asiatica*（Plate II：5－6）.

Pollen shape subspheroidal and 3-lobed circular in polar view；size（18－20.4）19 μm P×17.7（14－20.4）μm E. 3-colporate，the colpus membrane was covered with fine granules；the exine surface finely reticulate. According to Dickison，an“inaperturate”form of two species of New World tetraceras was observated，i.e. *Tetracera portobellensis* and *T. parviflora*（Dickison *et al*，1982，p. 1062－1064，figs 23－24；25－26）。

Hibbertica Andr. only study *H. riparia*（Plate II：7－8）.

Pollen shape subspheroidal and 3-lobed circular in polar view；size（19.1－28.1）25.3 μm P×24.9（20.4－25.5）μm E；3-colporate，the colpus membrane was covered by coarse granules；the exine surface reticulate，the lumina are wide and muri are narrow and uplift.

Ochnaceae study one species，*Ochna integerrima*（Plate II：9－10）.

Pollen shape subspheroidal and 3-lobed circular in polar view；size 28.1－33.2 μm in diameter. 3-colporate，with nearly square endopores and thickening edge（margo），which forming a labrum（Plate II：10，arrow）；the exine surface faintly granulate to finely granulate.

2.3 Actinidiaceae

The Actinidiaceae are a family of more than 80 species belonging to two genera，*Actinidia* Lindl. and *Clematoclethra* Maxim，and all of them are distributed in E. Asia. In Some schemes of classification the genus *Saurauia* was included in Actinidiaceae and therefore there are 3 genera，ca. 400 species in the family（Willis，1973），but here the authors only concluded the former two genera in it and the genus *Saurauia* was studied as a separate family Saurauiaceae，which was usually adopted by most Chinese workers.

Actinidia Lindl. Study 4 species：*A. chinensis*（Plate II：11），*A. lijiangensis*（Plate II：12），*A. guilinensis*（Plate III：1）and *A. macrosperma*（Plate III：2－3）.

Pollen shape subspheroidal（most species）to prolate（a few species）and 3-parted circular in polar view；3-colporate，the colpus membrane was covered with faint granules；the exine surface faintly granulate to finely granulate and there is no obviously difference among species. However，the size is different，for example *A. chinensis* is（17.9－23）20 μm P×20.5（17.9－23）μm E；*A. lijiangensi*（23－28.1）25.5 μm P×17.5（15.3－20.4）μm E；*A. guilinensi*（23－30.6）25.4 μm P×19.8（12.8－20.4）μm E and *A. macrosperma*（20.4－26.8）24.4 μm P×19.8（17.9－23）μm E.

Clematoclethra Maxim. Study 3 species：*C. actinidioides*（Plate III：4），*C. lasioclada*

(Plate III: 5) and *C. faberi*.

Pollen shape subspheroidal to prolate and nearly 3-lobed circular in polar view; 3-colporate, the colpus membrane was covered sparsely with granules; the exine surface faintly granulate to finely granulate. Size: *C. actinidioides* (14 – 20.4) 17 μm P × 15.7 (14 – 19.1) μm E; *C. lasioclada* (12.8 – 17.9) 15 μm P × 16.3 (15.3 – 17.9) μm E; *C. faberi* (18 – 20.4) 19 μm P × 17.7 (14 – 20.4) μm E.

Saurauiaceae only study *Sauraui. thyrsiflora* (Plate III: 6).

Pollen shape subspheroidal and 3 (– 4) lobed circular in polar view; 3 (– 4) colporate, the colpus membrane was covered sparsely with granules; size 20.4 – 25.5 μm P × 23.0 – 26.8 μm E; the exine surface punctate to foveolate.

2.4 Staphyleaceae

Staphylea L. Study 2 species, *Staphylea forrestii* (Plate IV: 1 – 2) and *S. bumalda* (Plate IV: 3 – 4).

Pollen shape subspheroidal and 3 lobed circular in polar view; 3-colporate, the colpus membrane was covered with fine granules; the pollen size from (30.6 – 47.1) 39.2 μm P × 35.3 (30.6 – 40.8) μm E in *Staphylea forrestii* to (35.7 – 45.9) 40.5 μm P × 42 (36.5 – 47.9) μm E in *S. bumalda*; the exine surface foveolate to finely reticulate and the lumina in mesocolpium are bigger and deeper than that in the regions of polar and colpus margins. The muri are wide and lunima are narrow but round.

Turpinia Vent. Study two species: *T. pomifera* (Plate IV: 5 – 6) and *T. affinis* (Plate IV: 7 – 8).

Pollen shape subspheroidal and 3 lobed circular in polar view; 3-colporate, the colpus membrane was covered with granules; the pollen size from (25.5 – 30.6) 28.8 μm P × 32.3 (30.6 – 35.7) μm E in *T. pomifera* to (30.6 – 35.7) 32.6 μm P × 36.6 (33.2 – 40.8) μm E in *T. affinis*; the exine surface foveolate to finely reticulate and the lumina in mesocolpium are bigger and deeper than that in polar area and colpus margins. As a whole, the pollen grains of *Turpinia* are very similar to that of *Staphylea* especially the exine sculpture except that the pollen grains of Staphylea are relatively bigger and the colpi are longer in *Staphylea* (Plate IV: 1, 3) but the pollen grains of *Turpinia* are slightly smaller and the colpi are shorter (Plate IV: 5, 7).

Tapiscia Oliv. Study two species: *T. sinensis* (Plate IV: 9 – 10) and *T. yunnanensis* (Plate IV: 11 – 12).

Pollen shape subspheroidal and 3 lobed circular in polar view; 3-colpate, the colpi are very wide and the colpus membrane was covered with faint granules; the pollen size from (13.3 – 17.9) 15.3 μm P × 15.4 (12.8 – 17.9) μm E in *T. sinensis* to (15.3 – 17.9) 15.7 μm P × 14.6 (12.8 – 15.3) μm E in *T. yunnanensis*; the exine surface finely reticulate with more width lumina of round or abnormal outline but even distribution on the whole pollen surface and with relatively narrow and moderate width of muri (Plate IV: 9 – 12).

The pollen grains of *Tapiscia* Oliv. are distinct from *Staphylea* and *Turpinia* by having 3-colpate

and smallest pollen grains in the family , in addition, the colpi are very wide and the exine reticulation with more width lumina in *Tapiscia*.

2.5 Theaceae

Theaceae are a tropical & subtropical family, distributed mainly in Asia., some to N. America, N. & S. Americas, Oceania and even to Africa. There are 25 genera and about 500 species. One of present authors had mad a detailed study on the pollen morphology of the family (1997). The family has long been divided into two subfamilies, i.e., Theoideae and Ternstroemoideae, of which the pollen morphology is different in the shape, the size and exine sculpture etc., for example the pollen shapes of Theoideae are oblate to subspheroidal, and a few prolate, with medium size of 30 – 45 (50) μm P × 33 – 50 (55) μm E; the exine sculptures include granulate, rugulate, feveolate, finely reticulate and verrucate etc., but the pollen of Ternstroemoideae is spheroidal to subspgheroidal in shape; the size 15 – 20 μm in diameter and with nearly smooth (psilate) to foveolate sculpture. For comparison, this paper only listed *Camellia luopingensis*, *C. oleifera*, *C. indochinensis*, *C. sinensis*, *Schima bambusifolia*, *Tutchera pubicostata*, *Cleyera albopunctata*, *Anneslea fragrans*, *Apterosperma oblata* and *Adinandra millettii* and so on. (table 1 and plates III, V ; cf. Wei etc., 1992, platesI – VIII; Wei , 1997 plates I – IV).

3 Discussion

3.1 As a whole, the pollen morphology of Stachyuraceae is nearly consistent among species. The pollen shape is subspheroidal to subprolate and in polar view is 3-lobed circular; ca. 18 – 28.2 μm P × 17.5 – 26.5 μm E ;3-colporate and the colpus membrane was covered with granules more or less ;the exine surface punctate to foveolate ;the size, the shape and even the distribution of foveolae are very similar among species with the exception of *S. salicifolius* in which the foveolae are not very obvious and the distribution of foveolae is uneven which showed difference from other species (Plate I : 9 – 10)。

3.2 The pollen morphology of Stachyuraceae, Dilleniaceae, Actinidiaceae, Saurauiaceae, Ochnaceae, Staphyleaceae and Theaceae showed some similarities each other, but as a whole, the pollen grains of Stachyuraceae are more similar to that of Staphyleaceae and Ternstroemoideae (Theaceae) in the shape and the exine sculpture, especially in exine sculpture.

3.3 The pollen mporphology of Theaceae showed more varieties in shape, size and exine sculpture, especially subfamily Theoideae which is different from Stachyuraceae. However, the pollen grains of Ternstroemoideae are similar to that of Stachyuraceae in shape and sculpture, for example the pollen shape is spheroidal to subspheroidal, exine surface punctate to foveolate (plate I : 1 – 12 ; II : 1 – 2 ; III : 7 – 9, 11 – 12).

3.4 From comparison, we can see that the pollen grains of Staphyleaceae are more similar to that of Stachyuraceae though the pollen size is different among genera of Staphyleaceae, for example the pollen sizes of *Staphylea* and *Turpinia* are (25.5 – 30.6) 28.8 μm P × 32.3 (30.6 – 35.7) μm Eand (30.6 – 35.7) μm E and (30.6 – 35.7) 32.6 μm P × 36.6 (33.2 – 40.8) μm E respectively ; but

the pollen of *Tapiscia* is very small, only 12.8 – 17.9 μm in diameter. In addition, the exine surface of Stachyuraceae is punctate to foveolate and that of Staphyleaceae is foveolate to finely reticulate, which showed slightly difference.

In a word, though pollen morphology plays a certain role in clarifying the relationships among different taxa, their role is not very obvious to elucidate the relationships of above families. But as a whole, the pollen morphology showed that Stachyuraceae may be more related to Staphyleaceae and Ternstroemoideae (Theaceae). However, their relationships showed in palynology are not so obvious as showed in molecular biology as reported by Nandi *et al*.

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Explanation of Plates

Plate I　1. *Stachyurus retusus*；2 – 3 *S. chinensis*；4 – 5 *S. yunnanensis*；6. *S. cordatulus*；7 – 8 *S. praecox*；9 – 10 *S. salicifolius*；11. *S. oblongifolius*；12. *S. himalaicus*. amplifing multiple：1，6，9 – 10，12 × 3，000；7 – 8，11 × 2，400；others see rulers.

Plate II　1 – 2 *Stachyurus obovatus*；3 – 4 *Davilla kunthii*；5 – 6 *Tetracera asiatica*；7 – 8 *Hibbertica riparia*；9 – 10 *Ochna integerrima*；11 *Actinidia chinensis*；12 *A. lijingensis*. amplifing multiple：1 – 2 × 3，000；3 – 4，7 – 8 × 2，400；5 – 6 × 3，600；9 × 1，800；10 × 2，100；11 – 12 × 2，400.

Plate III　1 *Actinidia guilinensis*；2 – 3 *A. macrosperma*；4 *Clematoclethra actinidioides*；5 *C. lasioclada*；6 *Saurauia thyrsiflora*；7 – 8 *Anneslea fragrans*；9 *Cleyera albopunctata*；10 *Apterosperma oblata*；11 – 12 *Adinandra millettii*. amplifing multiple：1 – 2，4 – 6 × 2，400；3 × 6000；others see rulers.

Plate IV　1 – 2 *Staphylea forrestii*；3 – 4 *S. bumalda*；5 – 6 *Turpinia pomifera*；7 – 8 *T. affinis*；9 – 10 *Tapiscia sinensis*；11 – 12 *T. yunna*. amplifing multiple：1 – 2，4，7 × 1，500；3 × 1，320；5 – 6，8 × 1，800；9 – 12 × 3，600.

Plate V　1. *Camellia luopingensis*；2. *C. oleifera*；3. *C. indochinensis*；4. *C. sinensis*；5. *Schima bambusifolia*；6. *Tutcheria pubicostata*. amplifing multiple：see rulers.

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